Deployment and Evaluation of IEEE 802.11 based Wireless Mesh Networks in campus environment

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ABSTRACT - Wireless Mesh Networks (WMNs) can be considered as hybrid between wireless infrastructure (WLAN) and ad-hoc networks (MANET), with mesh points providing flexibility in building & expanding the network, allowing automatic discovery of neighboring nodes, increased reliability and redundancy. In this paper we discuss as to how WMNs can be practically deployed to support wireless multihop communications in a campus-wide area. To this aim, we have deployed a real WMN at PEC University of Technology campus utilizing state-of-the-art technology and analyzed the performance of this architecture when supporting multihop heterogeneous traffic. Currently the network is being used to provide services to the residential areas of the campus.

Keywords:- Wireless Mesh Network; testbed; IEEE 802.11s draft; performance evaluation

I. INTRODUCTION

WMNs are easy to install, require no cable cost, connections amongst nodes are automatic, offer network flexibility, discovery of newly added nodes, redundancy, and self healing reliability. WMNs are important for distributed applications that cannot rely on a fixed infrastructure, but require instant deployment, dynamism, self-configuration and self-organization. The main contribution of this paper is reporting our experiences of deploying a real Wireless Mesh Network which is used as a testbed for validation of experimental results and offer services to campus residential.

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II. NEED AND ANALYSIS OF DEPLOYING WMN IN THE CAMPUS

Prior to the above mentioned testbed, the university had marginal network connectivity to the faculty residential areas. The academic area is fully connected using gigabit wired network. Looking at the architecture of low lying residences and scattered locations around the campus, the only choice available was ADSL connectivity. Wireless connectivity was desirable as most of the faculty members have laptops at homes. Traditional wireless connectivity through Access Points required a wired backbone and placement of switches and laying down of structured cables. It was a challenging task to provide wireless connectivity which did not require lying of cables. The above problem was solved by creating a wireless mesh network offering a robust, secure and easy connectivity to the above users as the mesh APs can be plugged onto the electrical poles without having any need to stretch Ethernet cables unlike wifi Access Points.

III. WMN TESTBED DEVELOPMENT

We have build WMN testbed at PEC University of Technology campus, under the Cyber Security Research Center, Chandigarh. The areas marked with red line in Fig. 2 indicate the areas of interest where there was no connectivity existing. The total area covered by the current WMN spans over 1000x700 sq mts. Shaded triangles in the Fig 2 depict the position of the mesh points. The white rectangle depicts the position of the mesh portal. The location of the mesh portal was chosen based upon the last mile wired connectivity that was available in the campus. Beyond this point wired connectivity did not exist in any form. Fig. 1 shows the snapshots of the actual mesh points and the mesh portal being deployed in the network. Since the power supply already existed in the form of street light poles and hence the existing light poles were being used for ease of installation.

IV. THE WMN TESTBED IN ACTION

In this section we report preliminary experimental outcomes achieved through our WMN testbed. The purpose

Fig 1(a) Mesh Portal connected through Ethernet

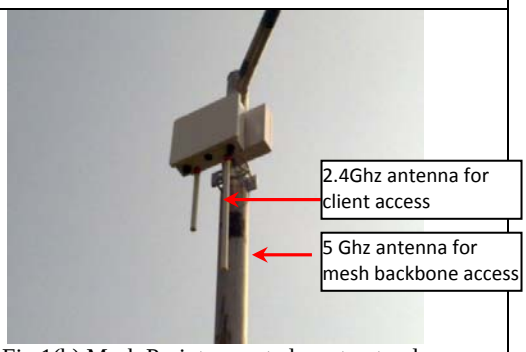

Fig 1(b) Mesh Porint mounted on street pole

Fig 1: Snapshots of Mesh Radios

of these experiments is to assess the functioning of our test bed and to evaluate the performance. We used the Netstumbler tool running on a Linux laptop equipped with a wireless IEEE 802.11g based PCI card to take signal strength measurements at various locations around the campus.

The measured SNR values (in dB) are shown in the Fig. 2. The SNR values show satisfactory results and hence justify the location of mesh points in WMN and hence the overall architecture. This also results in overall user satisfaction while accessing Internet through the Wireless Mesh Network. We conducted another experiment to measure the time taken to download a file when a client was accessing the network through different hops. In our experiment, we run a single download session over wireless mesh network, varying the number of hops that a packet has to transverse from the source to the desired destination; the client has to download the 4.91 MB file. The Mesh devices were positioned as depicted in the Fig. 2 whereas the position of the client were made to vary on the basis of different hops. When the client was directly connecting to a Mesh portal, it was considered to be operating through a single hop network. The client was then moved in such a way that it would connect to different mesh points to enable us to measure the performance at each hop. The time taken from each hop was measured and the results of the experiment are shown in Fig. 3 which depicts that the time taken to download the file increases linearly with the number of hops of flow transversal.

This is not surprising and indicates that our test bed is performing correctly; it is well known in the scientific literature that the available data rate for the TCP- based flows decreases for each wireless hop until it reaches a point where it is no more in a position to support any application.

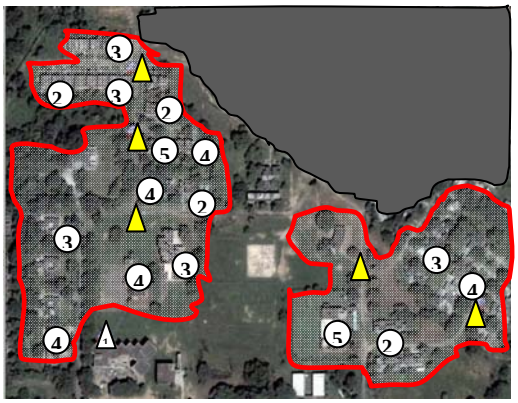

Fig 2: SNR (in dB) measured around the campus

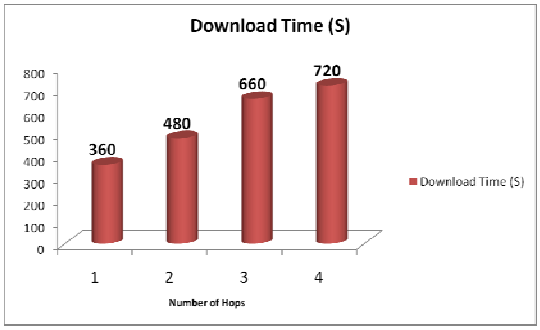

Fig: 3 Download time for a 4.9 MB file through FTP

V. CONCLUSION

In this paper, we have reported our experiences while deploying real wireless multihop testbed utilizing WMN technology based on the ORiNOCO AP's. Based upon the results presented in this paper, we claim that today's WMN technology is promising even if the performance quickly deteriorates when increasing the number of wireless hops between the source and the destination. A wise design of the network architecture that limits the number if consecutive wireless hops may generate a WMN which can satisfy the user's needs. Such a deployment clearly shows that the WMN has a huge potential in being able to rapidly deploy the network services without incurring high costs and laying down of cables. Moreover, besides serving as means to test and refine the practical applicability of wireless mesh network, the testbed also allows us to study many practical issues that inspired us to take future directions for this work.